AIRS IN ORBIT BIAS AND NOISE EVALUATION

CHANNEL BIAS

MEAN DIFFERENCE BETWEEN OBSERVED RADIANCE (CLEAR CONDITIONS) AND RADIANCE COMPARED FROM "TRUTH"

$$\Delta R = R_i^{OBS} - R_i^{COMP}$$

ERRORS IN PHYSICS, INSTRUMENT RESPONSE FUNCTION, CALIBRATION

ADD BIAS TO COMPUTED RADIANCES

NEEDED IN CLOUD CLEARING AND RETRIEVAL STEPS

CHANNEL NOISE

STANDARD DEVIATION BETWEEN OBSERVED (CLEAR CONDITIONS) RADIANCES AND BIAS CORRECTED RADIANCES COMPUTED FROM THE "TRUTH"

COMBINES INSTRUMENTAL NOISE AND COMPUTATIONAL NOISE

NEEDED FOR CHANNEL NOISE COVARIANCE MATRIX

TWO COMPLICATIONS

WHEN IS IT CLEAR

WHAT TO USE FOR TRUTH

EXPERIENCE WITH TOVS DATA

RAN RETRIEVALS ON 2X2 ARRAY OF HIRS2 SPOTS

CASE CALLED CLEAR IF ALL SPOTS THOUGHT TO BE CLEAR ≈ 30% OF ACCEPTED RETRIEVALS

- LOW CONTRAST BETWEEN SPOTS
- OBSERVED RADIANCES CLOSE TO WHAT IS EXPECTED

"TRUTH" USED 6 HOUR FORECAST T(P), Q(P) AND RETRIEVED T_{SKIN}

- FORECAST IS THOUGHT TO BE GLOBALLY UNBIASED FOR T(P)

COMPUTE BIAS FOR TEMPERATURE SOUNDING CHANNELS ONLY

- H4-H7, H13-H15, M2-M4
- WINDOW CHANNELS ASSUMED UNBIASED
- MOISTURE, OZONE CHANNELS NOT CORRECTED

FORM OF TOVS BIAS CORRECTION

BIAS DEPENDS ON SCENE, SATELLITE ZENITH ANGLE θ

USED FORM

$$\Delta\Theta_i = A_i + B_i\left(\Theta_i - \overline{\Theta}_i\right) + C_i \cos\theta + D_i\left(\Theta_i - \overline{\Theta}_i\right)\cos\theta$$

WHERE $\overline{\Theta}$ IS ENSEMBLE AVERAGE BRIGHTNESS TEMPERATURE

KEPT AN ENSEMBLE OF LATEST 2000 CASES

CASES MUST BE CLEAR

RETRIEVAL MUST BE ACCEPTED

RETRIEVAL MUST BE CLOSE TO FORECAST

KEPT TRACK OF AVERAGE BIAS EVERY TIME 150 NEW CASES ADDED

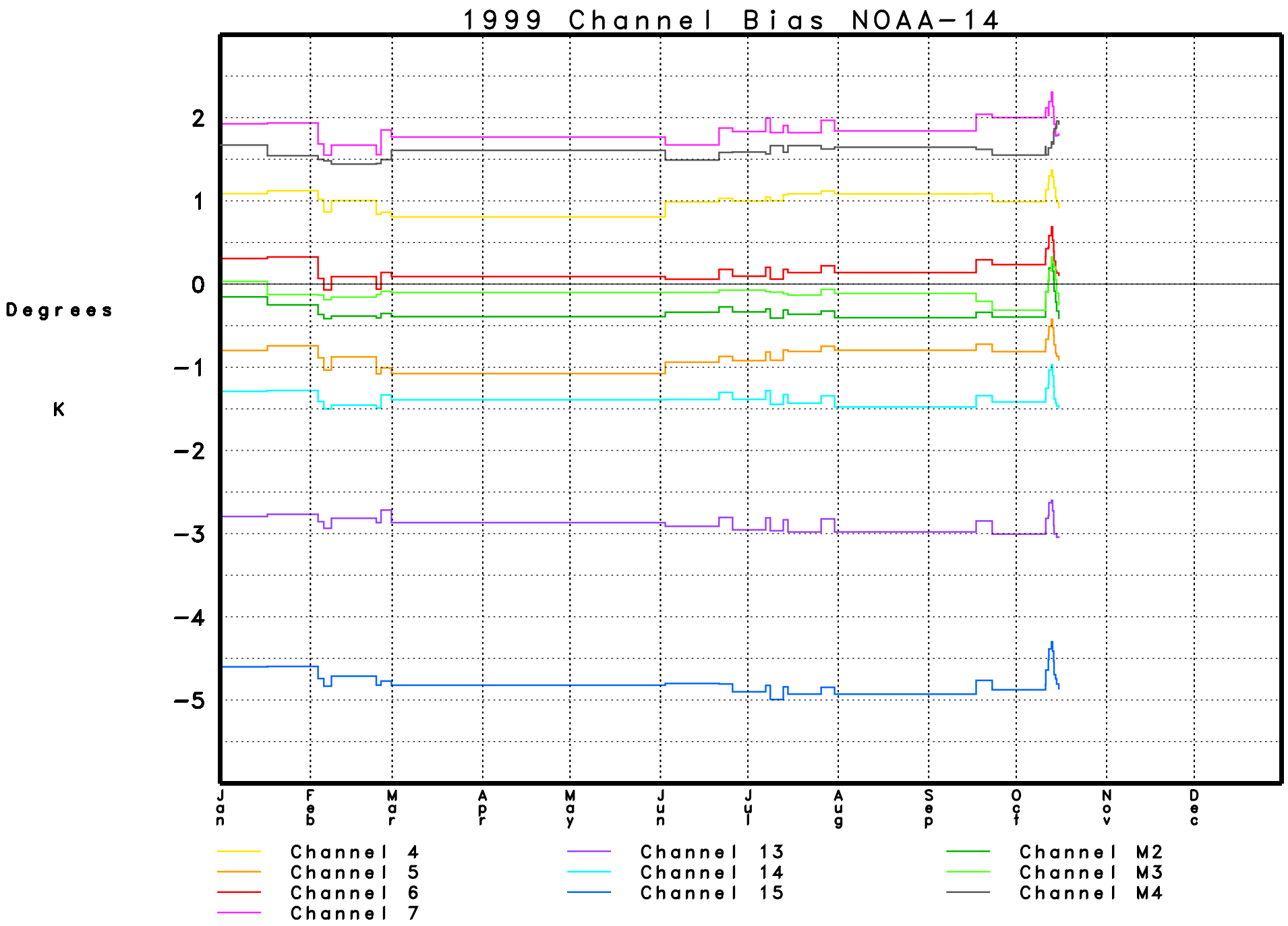
$$\overline{\Delta\Theta}_i^N = A_i^N + C_i^N \overline{\cos\theta} = A_i^N + 0.82C_i^N$$

CHANGE TO NEW COEFFICIENTS IF $\left|\overline{\Delta\Theta}_i^N - \overline{\Delta\Theta}_i^O\right| > 0.3$K FOR ANY CHANNEL

$\overline{\Delta\Theta}_i^O$ IS BASED ON COEFFICIENTS USED TO PRODUCE RETRIEVALS

NEW COEFFICIENTS BECOME OLD COEFFICIENTS IF CHANGED

COEFFICIENTS CHANGE SLOWLY WITH TIME


1999 Channel Bias NOAA-14
Degrees
K
2
1
0
−1
−2
−3
−4
−5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Channel 4
Channel 5
Channel 6
Channel 7
Channel 13
Channel 14
Channel 15
Channel M2
Channel M3
Channel M4

APPROACH WITH AIRS

CLEAR TEST

WE USE EQUATION

$$\hat{R}_i = R_{i,AVG} + \sum_j \eta_j \left(R_{i,AVG} - R_{i,j} \right) = R_{i,AVG} + \sum_j \Delta R_{i,j}$$

FOR j=1,9 FIELDS OF VIEW

WE LOOK AT EIGENVALUES OF $\Delta R' N^{-1} \Delta R$ FOR 76 CLOUD FILTERING CHANNELS

N IS CHANNEL NOISE COVARIANCE MATRIX

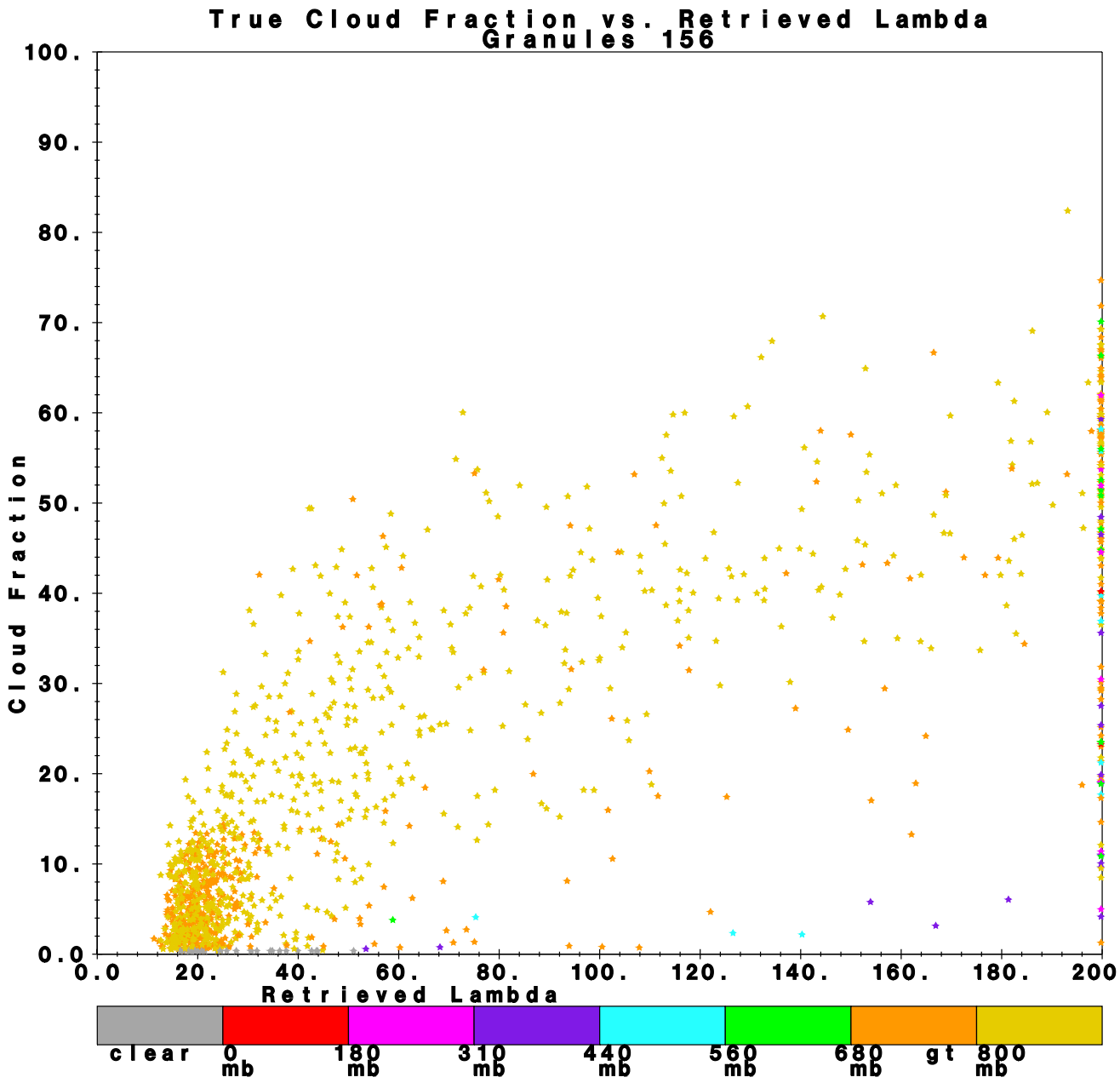
LARGE EIGENVALUES IMPLY CLOUD FORMATIONS

CURRENTLY SAY CLEAR IF NO EIGENVALUE GREATER THAN 20

SET ALL $\eta_j = 0$

APPROACH NEEDS REFINEMENT AS A CLEAR CASE TEST

CAN ALSO USE RETRIEVED CLOUD FRACTION α



Retrieved Lambda

Global mean = 285.64

Variance = 1624.59

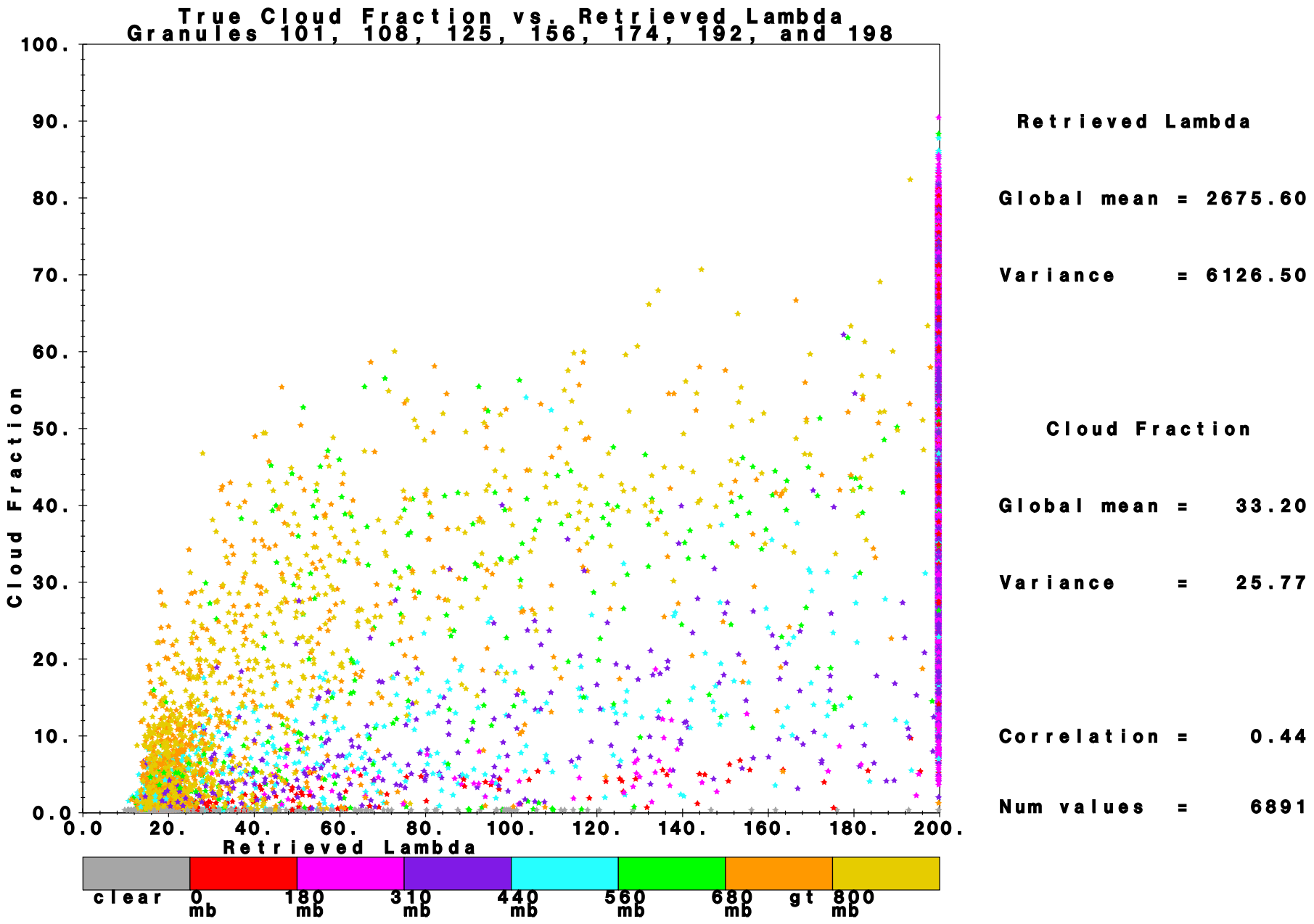
Cloud Fraction

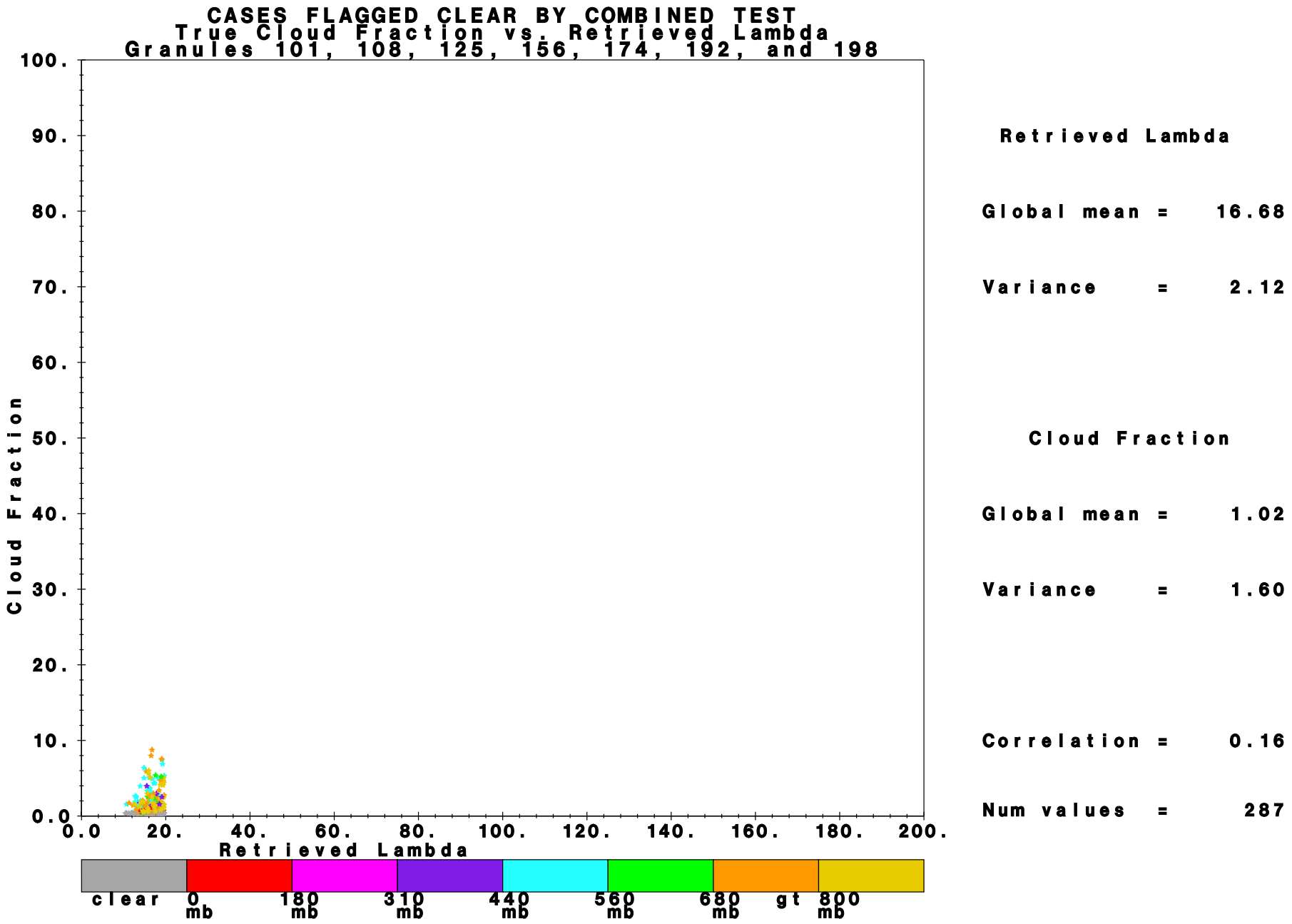
Global mean = 18.83

Variance = 18.90

Correlation = 0.21

Num values = 1281


True Cloud Fraction vs. Retrieved Lambda
Granules 101, 108, 125, 156, 174, 192, and 198
Cloud Fraction
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.0
0.0
20.
40.
60.
80.
100.
120.
140.
160.
180.
200.
Retrieved Lambda
clear
0 mb
180 mb
310 mb
440 mb
560 mb
680 mb
gt 800 mb
Retrieved Lambda
Global mean = 2675.60
Variance = 6126.50
Cloud Fraction
Global mean = 33.20
Variance = 25.77
Correlation = 0.44
Num values = 6891


CASES FLAGGED CLEAR BY COMBINED TEST
True Cloud Fraction vs. Retrieved Lambda
Granules 101, 108, 125, 156, 174, 192, and 198
Cloud Fraction
100.
90.
80.
70.
60.
50.
40.
30.
20.
10.
0.0
0.0
20.
40.
60.
80.
100.
120.
140.
160.
180.
200.
Retrieved Lambda
clear
0 mb
180 mb
310 mb
440 mb
560 mb
680 mb
gt 800 mb
Retrieved Lambda
Global mean = 16.68
Variance = 2.12
Cloud Fraction
Global mean = 1.02
Variance = 1.60
Correlation = 0.16
Num values = 287

TRUE CLOUD COVER STATISTICS FOR CLEAR FLAG TEST

TRUE CLEAR CASES ($\alpha_{TRUE} < .02$)

GRANULE	TRUE CLEAR	AVG COVER %	FOUND CLR $\lambda < 20$	AVG COVER %	FOUND CLR $\lambda < 20, \alpha < .02$	AVG COVEI
101	17	1.36	7	1.32	2	1.81
108	26	0.41	14	0.29	9	0.23
125	639	0.32	328	0.25	175	0.29
156	211	0.82	106	0.92	49	0.67
174	3	1.03	0	0	0	0
192	26	1.26	7	1.31	1	1.22
198	0	0	0	0	0	0
ALL	922	0.49	462	0.44	236	0.39

TRUE CLOUDY CASES ($\alpha_{TRUE} < .02$)

GRANULE	TRUE CLOUDY	AVG COVER %	FOUND CLR $\lambda < 20$	AVG COVER %	FOUND CLR $\lambda < 20, \alpha < .02$	AVG COVEI
101	868	40.78	43	13.24	2	5.07
108	1024	49.61	2	4.06	0	0
125	577	14.67	54	4.26	28	3.68
156	1070	22.38	210	6.33	19	4.26
174	919	42.86	3	3.89	1	4.85
192	968	34.73	3	3.11	1	2.15
198	551	67.27	0	0	0	0
ALL	5969	38.26	315	6.85	51	3.95

WHAT TO USE FOR "TRUTH"

WE DO NOT PLAN TO USE A FORECAST MODEL IN OUR ANALYSIS OF THE DATA

RADIOSONDES ARE SPARSE (NEED CLEAR CASES) AND INCOMPLETE VERTICALLY

WE PLAN TO USE THE SOLUTION AS "TRUTH"

- MANY REDUNDANT CHANNELS AT MOST LEVELS
- SOLUTION SHOULD NOT BE AFFECTED BY BIASES IN A GIVEN CHANNEL

STATISTICS KEPT FOR LAST 2000 CLEAR ACCEPTED CASES

UPDATE BIAS COEFFICIENTS WHEN A CHANNEL AVERAGE BIAS CHANGES CONSIDERABLY

FORM OF BIAS EQUATION

CHANNEL BIAS DEPENDS ON STATE, ZENITH ANGLE

THE FOLLOWING FORM IS PROBABLY SUFFICIENT

$$\Delta\Theta_i = A_{i,0} + \sum_{j=1}^{15} A_{i,j}\left(\Theta_j - \overline{\Theta}_j\right) + \sum_{k=1}^{4} B_{i,k}\left(\Theta_k - \overline{\Theta}_k\right) + C_i \sec\theta$$

WHERE Θ_j AND Θ_k ARE OBSERVED AMSU AND HSB RADIANCES

$\overline{\Delta\Theta_i} = A_{i,0} + 0.82\,C_i$ IS MONITORED FOR CHANGES